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Influence of Biofertigation and Crude Edible Oils Application on Growth Characteristics of Papaya (*Carica papaya* L.) cv. Red Lady

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was carried out to know the influence of biofertigation and crude edible oils application on growth, floral and fruit characteristics of papaya (*Carica Papaya* L.*)* cv. Red Lady was carried out at Department of Fruit Science, Dr. YSRHU-College of Horticulture, Venkataramanannagudem, West Godavari district of Andhra Pradesh during 2021-22 and 2022-23.

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The experiment was carried out in a Factorial RBD with three replications consisted of two factors *viz*., biofertilizers at three levels (B_1: 5 ml each of NFB + PSB + KRB; B_2: 2.5 ml each of NFB + PSB + KRB; B_3: Without biofertilizer) and crude edible oil at five levels (C_1: Ground nut oil @0.5%; C_2: Castor oil @0.5%; C_3: Mustard oil @0.5%; C_4: Ground nut oil + Castor oil + Mustard oil @0.5%; C_5: No crude oil spray) with fifteen treatment combinations. Among the treatments studied, the results revealed that the maximum plant height, stem girth, number of leaves per plant at 360 DAT were registered in the plants with biofertigation of 5 ml each of biofertilizers NFB + PSB + KRB (B_1), spraying of crude edible oils *viz.*, with ground nut oil + castor oil + mustard oil @0.5% (C_4)] and their interaction *i.e.* plants applied with 5 ml each of biofertilizers NFB+ PSB + KRB along with ground nut oil + castor oil + mustard oil @0.5% (B_1C_4).

Keywords: Papaya; biofertigation; edible oils; NFB; PSB and KRB; crude oil spray; fertilizers; biofertilizers.

1. INTRODUCTION

Papaya (*Carica papaya* L.) is an evergreen herbaceous commercial fruit crop of tropical and subtropical regions and belongs to the family Caricaceae with chromosome number 2n=18. Papaya is a dicotyledon, polygamous and diploid species with geographical origin of Southern Mexico and Costa Rica [1]. Papaya is highly responsive to application of fertilizers. Though, chemical fertilizers fulfil the major requirement of the crop, their excessive and unbalanced use may lead to ecological hazards, depletion of physico-chemical properties.

Use of biofertilizers in papaya supplies plant nutrients to an optimum level besides maintenance of soil fertility for sustainable desired crop productivity and fruit quality through optimization of benefits from all possible sources in an integrated manner. Liquid biofertilizers have the ability to fix/solubilize the plant nutrients in soil through biological process. They are environmental friendly and play a significant role in crop production [2].

N-fixing bacteria possess unique potential of fixing atmospheric nitrogen either by living symbiotically or non-symbiotically or to transform native soil nutrients from non-usable to usable form through biological process [3]. Azotobacter have also been found to promote synthesis of growth promoting substances like auxins, gibberellins, cytokinins and antibiotic metabolites which in turn improved resistance against biotic and abiotic stress [4]. Phosphate solubilizing bacteria play an important role in supplementing phosphorus to plants [5]. The principal mechanism of mineral phosphate solubilization is the production of organic acids and acid phosphatases which play a major role in the mineralization of phosphorous in the soil [6]. Most of the mineral potassium of the soil is unavailable for plant uptake [7]. Potassium releasing bacteria (KRB) mediate the releasing of potassium bearing minerals through production and excretion of organic acids [8].

A lot of organic substances have been found effective in the maintenance of soil and plant health thus giving positive results for growth, yield and quality of different crops. Traditionally the organic edible oil is used as a fertilizer for farming to get high quality yields with low cost per crop [9]. Recently farmers are adopting the practice of application of crude edible oils obtained from ground nut, castor and mustard seeds *etc.,* to get good growth and higher yield with better quality in some of the fruit crops. There is a need to analyse the effect of foliar application of crude edible oils on growth, yield and quality of papaya.

Now-a-days, farmers are opting fertigation which ensures precise timing and uniform distribution of nutrients and is an efficient and agronomically sound method of providing soluble plant nutrients directly to the active plant root zone. Biofertigation with liquid biofertilizers is the efficient and precise use of beneficial microorganisms through a microirrigation system over carrier based biofertilizers. The research on liquid biofertilizers is on the rise during the recent past and several products containing live strains have been commercialized for their use in agriculture. However, limited attempts have been made to study the influence of liquid formulations on the growth, yield and quality of fruits in India and there is need to validate the advantage of liquid formulations. Similarly, crude edible oils application in papaya is not known to have been tried before.

Keeping these points in view, the present investigation entitled “Effect of biofertigation and crude edible oils application on growth characteristics of papaya (*Carica papaya* L.) cv. Red Lady” was planned with the following objectives:

1. To study the effect of biofertigation along with chemical fertilizers on growth characteristics of papaya.
2. To evaluate the effect of foliar sprays of crude edible oils on growth characteristics of papaya.
3. To know the efficacy of biofertigation along with chemical fertilizers and foliar sprays of crude edible oils on growth characteristics of papaya.

2. MATERIALS AND METHODS

The current investigation, “Influence of biofertigation and crude edible oils application on growth characteristics of papaya (*Carica Papaya* L.*)* cv. Red Lady was carried out at Department of Fruit Science, Dr. YSRHU-College of Horticulture, Venkataramanannagudem, West Godavari district of Andhra Pradesh during 2021-22 and 2022-23. The experiment was laid out in FRBD with three replications consisted of two factors *viz*., biofertilizers at three levels (B_1: 5 ml each of NFB + PSB + KRB; B_2: 2.5 ml each of NFB + PSB + KRB; B_3: Without biofertilizer) and crude edible oil at five levels (C_1: Ground nut oil @0.5%; C_2: Castor oil @0.5%; C_3: Mustard oil @0.5%; C_4: Ground nut oil + Castor oil + Mustard oil @0.5%; C_5: No crude oil spray) with fifteen treatment combinations.

T_1	:	B_1C_1	-	5ml each of NFB+PSB +KRB+ Ground nut oil @0.5%
T_2	:	B_1C_2	-	5ml each of NFB+PSB +KRB+ Castor oil @0.5%
T_3	:	B_1C_3	-	5ml each of NFB+PSB +KRB+ Mustard oil @0.5%
T_4	:	B_1C_4	-	5ml each of NFB+PSB +KRB+ Ground nut oil + Castor oil + Mustard oil @0.5%
T_5	:	B_1C_5	-	5ml each of NFB+PSB +KRB + no crude oil spray
T_6	:	B_2C_1	-	2.5ml each of NFB+PSB +KRB+ Ground nut oil @0.5%
T_7	:	B_2C_2	-	2.5ml each of NFB+PSB +KRB+ Castor oil @0.5%
T_8	:	B_2C_3	-	2.5ml each of NFB+PSB +KRB+ Mustard oil @0.5%
T_9	:	B_2C_4	-	2.5ml each of NFB+PSB +KRB+ Ground nut oil + Castor oil + Mustard oil @0.5%
T_{10}	:	B_2C_5	-	2.5ml each of NFB+PSB +KRB+ no crude oil spray
T_{11}	:	B_3C_1	-	Without biofertilizers + Ground nut oil @0.5%
T_{12}	:	B_3C_2	-	Without biofertilizers + Castor oil @0.5%
T_{13}	:	B_3C_3	-	Without biofertilizers + Mustard oil @0.5%
T_{14}	:	B_3C_4	-	Without biofertilizers + Ground nut oil + Castor oil + Mustard oil @0.5%
T_{15}	:	B_3C_5	-	Without biofertilizers + no crude oil spray

First dose of NFB, PSB and KRB liquid biofertilizers were applied at 15 days after transplanting. Second and third doses of liquid biofertilizers were applied respectively at three months and six months after transplanting. Foliar sprayings of different concentrations of crude edible oils were taken up at three intervals on first month, four months and seven months after transplanting. The method of application of liquid biofetilizers was done with the help of drip system which was connected to small tank and drip liners and crude edible oils were applied to the plants by spraying.

3. RESULTS AND DISCUSSION

3.1 Growth Parameter

3.1.1 Plant height (cm)

The influence of biofertigation and foliar application of crude edible oils and their interaction on plant height was presented in Table 1. Significant differences were noticed among the biofertigation treatments at all the stages of observations recorded. The plant height was gradually increased from 90 to 360 DAT. The plant height was maximum (106.60, 159.53, 207.42 and 257.89 at 90, 180, 270 and 360 DAT respectively) in B_1 (5 ml each of biofertilizers NFB (*Azotobacter chroococcum*) + PSB (*Bacillus megaterium*) + KRB (*Bacillus mucilaginosus*) followed by B_2 (2.5 ml each of NFB + PSB + KRB biofertilizers) (87.06, 145.93, 193.84 and 242.39 at 90, 180, 270 and 360 DAT respectively). The plant height was minimum (73.13, 119.23, 162.17 and 222.92 at 90, 180, 270 and 360 DAT respectively) in B_3 (without biofertigation).

The foliar application of crude edible oils had significantly influenced the plant height in papaya. The plant height was gradually increased from 90 to 360 DAT. The plant height

was more (93.51, 145.38, 194.49 and 249.46 at 90, 180, 270 and 360 DAT respectively) in C_4 (ground nut oil + castor oil + mustard oil @0.5%) treatment, followed by C_1 (ground nut oil @0.5%) treatment at 90 DAT (90.22) and 180 DAT (143.36) and C_4 was on par with C_3 (mustard oil @0.5%) treatment at 270 DAT (190.47) and C_4 followed by C_3 at 360 DAT (242.82). The plant height was minimum (84.84, 136.15, 178.61 and 230.48 at 90, 180, 270 and 360 DAT respectively) in C_5 treatment (without crude edible oil spray).

The interaction between the biofertigation and crude edible oils spray treatments was found significant for plant height at all the stages of observations recorded except at 90 DAT. The interaction of biofertigation and crude edible oils spray (B_1C_4) (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and 0.5% of ground nut oil + castor oil + mustard oil) recorded the maximum plant height (163.13, 215.43 and 268.53 at 180, 270 and 360 DAT respectively) followed by B_1C_1 (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and 0.5% of ground nut oil) at 180 DAT (160.93) and B_1C_3 (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and mustard oil @0.5%) at 270 DAT (210.54) and at 360 DAT (257.58). The plant height was minimum in B_3C_5 (without biofertigation and crude edible oils spray) at all stages of observations recorded (109.37, 145.52 and 209.48 at 180, 270 and 360 DAT respectively).

Though, plant height was genetically controlled trait, it could be manipulated with the application of biofertilizers and crude edible oils spray. The increase in the plant height with the application of biofertilizer along with crude edible oils might be due to better uptake and translocation of nitrogen to the growing points. The fact behind increase in plant height was due to application of nitrogen as it encourages vegetative growth through the formation of new cells, cell division, cell elongation and cell development [10]. The biofertilizers also help in fixing atmospheric nitrogen and also solubilization of phosphorous and potassium nutrients fixed to the soil particles by releasing organic acids through their metabolic process [2]. This resulted in vigorous growth of root system, which ultimately helped in better absorption of nutrients from soil and utilization of both nitrogen applied and fixed by NFB was reflected in terms of plant height. The results were in accordance with findings of Bharathi et al. [11], Kumar et al. [12] and Sourabh et al. [13] in guava and Sharma et al. [14] in mango cv. Amrapali, Amar et al. [15], Divya and Bindu [16] in papaya.

The crude edible oil sprays improved the plant height by supplying both primary and secondary macronutrients. As evident from the above the positive significant increase in plant height by the organic amendments used in the present investigation *i.e.* crude edible oils reminds the fact that these substances are directly or indirectly associated with maintenance of plant health. Similar results were reported by Dayeswari et al. [17] in Ber.

3.1.2 Stem girth (cm)

The influence of biofertigation and foliar application of crude edible oils and their interaction on stem girth was presented in Table 2. Significant differences were noticed among the biofertigation treatments at all the stages of observations recorded. The stem girth was gradually increased from 90 DAT to 360 DAT. The stem girth was maximum (12.28, 21.95, 30.02 and 35.77 at 90, 180, 270 and 360 DAT respectively) in B_1 (5 ml each of biofertilizers NFB + PSB + KRB) followed by B_2 (2.5 ml each of NFB + PSB + KRB biofertilizers) (10.66, 19.34, 23.95 and 29.60 at 90, 180, 270 and 360 DAT respectively). The stem girth was minimum (8.52, 16.67, 20.33 and 26.59 at 90, 180, 270 and 360 DAT respectively) in B_3 (without biofertigation).

The foliar application of crude edible oils had significantly influenced the stem girth in papaya. The stem girth was gradually increased from 90 DAT to 360 DAT. The stem girth was maximum (11.24, 20.25, 25.88 and 31.93 at 90, 180, 270 and 360 DAT respectively) in C_4 (ground nut oil + castor oil + mustard oil @0.5%) followed by C_1 (ground nut oil @0.5%) treatment at 90 DAT (10.63), 180 DAT (19.63) and 270 DAT (25.30) and C_2 (castor oil @0.5%) at 360 DAT (30.89). The stem girth was minimum (9.59, 18.12, 23.46 and 29.24 at 90, 180, 270 and 360 DAT respectively) in C_5 treatment (without crude edible oil spray).

The interaction between the biofertigation and crude edible oils spray treatments was found significant for stem girth at all the stages of observations recorded except at 90 DAT and 360 DAT. The interaction of biofertigation and crude edible oils spray *i.e.* B_1C_4 - the combination of 5 ml each of biofertilizers NFB + PSB + KRB and ground nut oil + castor oil + mustard oil @0.5% had recorded the maximum stem girth (23.06 and 31.36 at 180 and 270 DAT respectively)

Table 1. Effect of biofertigation and foliar application of crude edible oils on plant height (cm) of papaya cv. Red Lady

Crude edible oils (C)	Biofertilizers (B)															
	90 DAT			Mean of (C)	180 DAT			Mean of (C)	270 DAT			Mean of (C)	360 DAT			Mean of (C)
	B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3	
C_1	108.49	88.14	74.03	**90.22**	160.93	146.80	122.34	**143.36**	206.85	195.64	165.61	**189.37**	255.63	241.28	227.00	**241.30**
C_2	104.78	85.52	72.81	**87.70**	158.43	145.21	119.76	**141.13**	204.21	192.49	161.62	**186.11**	255.08	244.03	224.70	**241.27**
C_3	106.04	86.22	72.86	**88.37**	158.62	146.16	120.60	**141.79**	210.54	193.33	167.54	**190.47**	257.58	244.81	226.07	**242.82**
C_4	113.16	92.06	75.31	**93.51**	163.13	148.93	124.08	**145.38**	215.43	197.47	170.58	**194.49**	268.53	252.51	227.35	**249.46**
C_5	100.51	83.36	70.65	**84.84**	156.54	142.55	109.37	**136.15**	200.05	190.26	145.52	**178.61**	252.65	229.31	209.48	**230.48**
Mean of (B)	**106.60**	**87.06**	**73.13**		**159.53**	**145.93**	**119.23**		**207.42**	**193.84**	**162.17**		**257.89**	**242.39**	**222.92**	
Factors	**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**	
B	0.48		1.39		0.12		0.35		1.19		3.44		0.11		0.32	
C	0.62		1.79		0.16		0.45		1.53		4.44		0.14		0.42	
B x C	1.07		NS		0.27		0.78		2.65		7.68		0.25		0.72	

B_1: 5 ml each of NFB + PSB + KRB, B_2: 2.5 ml each of NFB + PSB + KRB, B_3: Without biofertilizer
C_1: Ground nut oil@0.5% C_2: Castor oil@0.5% C_3: Mustard oil@0.5% C_4: Ground nut oil + Castor oil + Mustard oil@0.5% C_5: No crude oil spray

Table 2. Effect of biofertigation and foliar application of crude edible oils on stem girth (cm) of papaya cv. Red Lady

Crude edible oils (C)	Biofertilizers (B)															
	90 DAT			Mean of (C)	180 DAT			Mean of (C)	270 DAT			Mean of (C)	360 DAT			Mean of (C)
	B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3	
C_1	12.43	10.87	8.58	**10.63**	22.51	19.96	16.42	**19.63**	31.02	24.22	20.66	**25.30**	35.75	29.05	27.03	**30.61**
C_2	12.10	10.86	8.44	**10.47**	22.39	18.80	16.70	**19.30**	30.26	23.84	20.25	**24.78**	36.63	29.86	26.18	**30.89**
C_3	12.29	10.47	8.78	**10.51**	21.43	19.77	16.71	**19.30**	29.82	23.36	20.04	**24.41**	35.36	29.86	26.53	**30.58**
C_4	12.90	11.59	9.25	**11.24**	23.06	20.02	17.68	**20.25**	31.36	25.26	21.03	**25.88**	37.62	30.52	27.66	**31.93**
C_5	11.70	9.53	7.55	**9.59**	20.36	18.15	15.84	**18.12**	27.66	23.07	19.66	**23.46**	33.49	28.71	25.53	**29.24**
Mean of (B)	**12.28**	**10.66**	**8.52**		**21.95**	**19.34**	**16.67**		**30.02**	**23.95**	**20.33**		**35.77**	**29.60**	**26.59**	
Factors	**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**	
B	0.10		0.29		0.11		0.33		0.14		0.41		0.25		0.71	
C	0.13		0.38		0.15		0.42		0.18		0.53		0.32		0.92	
B x C	0.23		NS		0.25		0.73		0.32		0.92		0.55		NS	

B_1: 5 ml each of NFB + PSB + KRB B_2: 2.5 ml each of NFB + PSB + KRB B_3: Without biofertilizer
C_1: Ground nut oil@0.5% C_2: Castor oil@0.5% C_3: Mustard oil@0.5% C_4: Ground nut oil + Castor oil + Mustard oil@0.5% C_5: No crude oil spray

Table 3. Effect of biofertigation and foliar application of crude edible oils on number of leaves per plant of papaya cv. Red Lady

Crude edible oils (C)	Biofertilizers (B)															
	90 DAT			Mean of (C)	180 DAT			Mean of (C)	270 DAT			Mean of (C)	360 DAT			Mean of (C)
	B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3		B_1	B_2	B_3	
C_1	18.56	15.33	13.53	**15.81**	24.93	20.26	16.87	**20.69**	31.01	26.05	22.69	**26.58**	36.18	36.03	27.11	**33.11**
C_2	17.75	15.27	12.72	**15.25**	23.84	19.04	16.04	**19.64**	30.43	25.22	22.48	**26.04**	36.22	33.42	27.02	**32.22**
C_3	18.18	15.16	13.16	**15.50**	25.78	19.68	16.53	**20.66**	30.66	25.87	22.47	**26.33**	36.34	33.34	27.42	**32.37**
C_4	19.06	15.90	13.88	**16.28**	27.65	21.74	17.33	**22.24**	32.26	28.53	23.95	**28.25**	37.35	34.89	28.82	**33.69**
C_5	16.85	14.94	12.01	**14.60**	23.52	18.98	15.78	**19.43**	29.29	25.02	21.06	**25.12**	34.49	32.04	26.33	**30.95**
Mean of (B)	**18.08**	**15.32**	**13.06**		**25.14**	**19.94**	**16.51**		**30.73**	**26.14**	**22.53**		**36.12**	**33.94**	**27.34**	
Factors	**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**		**S Em±**		**CD at 5%**	
B	0.10		0.28		0.03		0.08		0.02		0.07		0.03		0.08	
C	0.12		0.36		0.03		0.10		0.03		0.09		0.04		0.10	
B x C	0.21		NS		0.06		0.17		0.06		0.16		0.06		0.18	

B_1: 5 ml each of NFB + PSB + KRB B_2: 2.5 ml each of NFB + PSB + KRB B_3: Without biofertilizer
C_1: Ground nut oil@0.5% C_2: Castor oil@0.5% C_3: Mustard oil@0.5% C_4: Ground nut oil + Castor oil + Mustard oil@0.5% C_5: No crude oil spray

followed by B_1C_1 (The combination of 5 ml each of biofertilizers NFB + PSB + KRB and ground nut oil @0.5%) at 180 DAT (22.51) and 270 DAT (31.02). The stem girth was minimum in B_3C_5 (without biofertigation and crude edible oils spray) at all stages of observations recorded (15.84 and 19.66 at 180 and 270 DAT respectively).

The stem girth is a genetically controlled trait, it could be manipulated with the application of growth-related compounds. The increase in stem girth of papaya plants was noticed with the combined application of biofertilizers and crude edible oils might be attributed to high rate of nitrogen mineralization through NFB, release of potassium nutrient through KRB microorganisms leads to continuous supply of available nutrients from organic and inorganic form improved the stem girth by activation of lateral meristems.

The present results were in consonance with findings of Suneetha and Ramachandrudu [18] in oil palm; Kundu et al. [19] in mango cv. Amarapali, Bhatnagar and Singh [20] in custard apple cv. Arka Sahan; Amit et al. [21] in guava, Dayeswari et al. [17] in ber, Amar et al. [15], Divya and Bindu [16] in papaya.

3.2 Number of Leaves Per Plant

The influence of biofertigation and foliar application of crude edible oils and their interactions on number of leaves was presented in Table 3. Significant differences were noticed among the biofertigation treatments at all the stages of observations recorded. The number of leaves was gradually increased from 90 DAT to 360 DAT. The number of leaves was maximum (18.08, 25.14, 30.73 and 36.12 at 90, 180, 270 and 360 DAT respectively) in B_1 (5 ml each of biofertilizers NFB + PSB + KRB) followed by B_2 (2.5 ml each of NFB + PSB + KRB biofertilizers) (15.32, 19.94, 26.14 and 33.94 at 90, 180, 270 and 360 DAT respectively). The number of leaves was minimum (13.06, 16.51, 22.53 and 27.34 at 90, 180, 270 and 360 DAT respectively) in B_3 (without biofertigation).

The foliar application of crude edible oils had significantly influenced the number of leaves in papaya. The number of leaves was gradually increased from 90 to 360 DAT. The number of leaves was highest (16.28, 22.24, 28.25 and 33.69 at 90, 180, 270 and 360 DAT respectively) in C_4 (ground nut oil + castor oil + mustard oil @0.5%) followed by C_1 (ground nut oil @0.5%) (15.81, 20.69, 26.58 and 33.11 at 90, 180, 270 and 360 DAT respectively). The number of leaves was minimum (14.60, 19.43, 25.12 and 30.95 at 90, 180, 270 and 360 DAT respectively) in C_5 (without crude edible oil spray).

The interaction between the biofertigation and crude edible oils spray treatments was found significant for number of leaves at all the stages of observations recorded except at 90 DAT. The interaction of biofertigation and crude edible oils spray (B_1C_4 - the combination of 5 ml each of biofertilizers NFB + PSB + KRB and ground nut oil + castor oil + mustard oil @0.5%) had recorded the maximum number of leaves (27.65, 32.26 and 37.35 at 180, 270 and 360 DAT respectively) followed by B_1C_3 treatment (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and mustard oil @0.5%) at 180 DAT (25.78) and B_1C_1 treatment (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and ground nut oil @0.5%) at 270 DAT (31.01) and B_1C_3 treatment (the combination of 5 ml each of biofertilizers NFB + PSB + KRB and mustard oil @0.5%) at 360 DAT (36.34). The number of leaves was minimum in B_3C_5 (without biofertigation and crude edible oils spray) at all stages of observations recorded (15.78, 21.06 and 26.33 at 180, 270 and 360 DAT respectively).

Number of leaves is having direct correlation with photosynthetic efficiency of plants. The combined application of biofertilizers and crude edible oils had significantly increased the number of leaves per plant by continuous supply of water, harmones and nutrients to the meristamatic tissue and consequently produced more number of leaves per plant as earlier reported by Sumithra et al. [22] and Jain et al. [23]. The results are in close conformity with the findings of Shivakumar, [24], Suresh, et al. [25], Yadav, et al. [26] and Tandel et al. [27] in papaya, Sharma et al. [28], Godage et al. [29] in guava cv. Allahabad safeda, Kumar et al. [12] in guava and Maskar [30] in sapota.

4. CONCLUSION

On the basis of results obtained in the present investigation, it could be concluded that, the biofertigation with 5 ml each of biofertilizers NFB + PSB + KRB (B_1), spraying of crude edible oils *viz.*, with ground nut oil + castor oil + mustard oil @0.5% (C_4) and their interaction *i.e.* plants

applied with 5 ml each of biofertilizers NFB+ PSB + KRB along with ground nut oil + castor oil + mustard oil @0.5% (B_1C_4) performed best with respect to growth characteristics of papaya. Hence it could be concluded that biofertilizers and crude edible oils application were found more effective in maintaining the overall development of the papaya plant growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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